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N 70 17045

NASA CR 107791

Research in Space Physics at the University of Iowa

NGL-16-001-002

1969

[Prepared by J. A. Van Allen]

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6 October 1969

1. General Nature of the Work

The central objective of our work continues to be the extension of knowledge of the corpuscular radiations (particles) in outer space and of their relationships to electric, magnetic, and electromagnetic fields associated with the earth, the sun, the moon, the planets, and the interplanetary medium.

Principal emphasis is on observational work with progressively more sophisticated arrays of detectors flown on earth satellites and on planetary and interplanetary spacecraft to the full extent of the opportunities and techniques that can be developed. Secondary, but growing, emphasis is on supporting ground observations and on theoretical and interpretative work, especially on the physics of astrophysical plasmas.

Specific fields of investigation are the following:

(a) All aspects of the corpuscular radiations that are trapped in the earth's magnetic field and are transiently present in the outer magnetosphere including the magnetospheric tail of the earth; and of the solar, interplanetary, and terrestrial phenomena that are associated with these radiations (e.g., solar flares, interplanetary magnetic fields and plasma, aurorae, geomagnetic storms, corpuscular heating of the atmosphere, electromagnetic and electrostatic fields in the magnetosphere, and the ionospheric

effects of particle precipitation). This field of research was originated to a major extent by this laboratory.

(b) Solar and galactic cosmic rays and especially the origin of the former and the mechanisms of interplanetary propagation of both components. The direct detection of solar cosmic rays was first accomplished by this laboratory in 1958 and substantial contributions to this field have been made throughout the subsequent eleven years.

(c) Energetic electrons emitted from the sun (a phenomenon discovered by this laboratory in 1965) and their interplanetary propagation.

(d) Solar x rays and their relationship to particle and radio emission, and to the production of ionospheric effects.

(e) Origin and propagation of low frequency radio waves in the earth's magnetosphere.

(f) Radio frequency emissions from the sun and their relationships to particle-emitting flares.

(g) Interaction of the moon with solar and magnetospheric particles.

(h) The theory of wave phenomena in agitated plasmas and of the origin of super-thermal particles.

(i) Shock waves in the interplanetary medium.

(j) Magnetic fields of the planets, interaction of the solar wind with planets and magnetospheric phenomena of planets (especially Venus, Mars, and Jupiter).

2. New Facilities

A 90,000 sq. ft. addition to the existing Physics Research Center has been under construction since 17 October 1968 and is over half completed at this date. Occupancy is planned for August 1970. The addition will be devoted to offices, library, classrooms, lecture rooms, and instructional laboratories of the Department of Physics and Astronomy and of the Department of Science Education. Upon its completion, about 15,000 square feet of additional space will be made available for research laboratories in the existing Physics Research Center.

3. Specific Current Projects

(a) Study of Data from "Old" Spacecraft

Student thesis investigations on geomagnetically trapped radiation are continuing on data from Injun IV, Explorer XIV, OGO I, OGO II, OGO III, OGO IV, and OGO V. Interplanetary particle measurements by Mariner II, Mariner IV, and Mariner V are being further analyzed in collaboration with other experimenters. The Mariner V solar x-ray data are being studied jointly with simultaneous data from Explorers 33 and 35 to

determine the angular distribution of soft solar x rays and the altitude of their points of origin in the solar atmosphere.

(Supported by ONR or NASA as appropriate)

[Van Allen, Craven, Ackerson, Owens, Frank, Catalano, Rao, and Burns]

(b) Injun V (Explorer 40)

Injun V is a 157 lb. spacecraft built at the University of Iowa and launched successfully from the Western Test Range into a near-polar orbit on 8 August 1968.

Its purposes are (a) to determine in full spectral, temporal, and angular detail the beams of electrons and protons (100 to 50,000 eV) that produce the aurorae, (b) to study with very sensitive radio receivers a wide variety of phenomena involving very low frequency radio emissions in the magnetosphere and ionosphere of the earth, (c) to obtain improved spectral, temporal, and positional dependences of geomagnetically trapped protons, electrons, and alpha particles, (d) to determine the total corpuscular energy input into the upper atmosphere, (e) to study the occurrence of solar proton and alpha particle events, the arrival of such particles over the earth's polar caps and the production of polar cap radio absorption (communication "black-outs"), and (f) to measure density and temperature of thermal and super-thermal electrons in the upper ionosphere.

This satellite continues to operate well after 14 months in orbit.

The University of Iowa/Office of Naval Research Data Acquisition Facility, the North Liberty Radio Observatory, is the primary command and telemetry receiving station for Injun V.

Several papers have already been published.

Full scale production of master data tapes including all pertinent orbital data will commence in the near future. Most of the computer programs for large scale reduction, analysis, and plotting of data are completed.

The Injun V program is a major one of the laboratory. It is now expected that we will be able to continue the flight operations for a total of 24 months (or until some significant failure occurs).

The reduction, analysis, and publication of Injun V data will continue as a major activity for the upcoming two or more years. There are already adequate data on hand to serve most of the objectives listed above.

(Hardware and other pre-flight support by Langley Research Center/NASA. Operation of the North Liberty Radio Observatory and macro-data reduction by the Goddard Space Flight Center/NASA. Experimenters' data analysis by Langley Research Center/NASA. Basic station facilities at NLRO by Office of Naval Research.)

[Van Allen, Frank, Gurnett, Pfeiffer, Mosier, Pizzella, Anderson, Cauffman, Rogers, Enemark, Randall, Brechwald, and supporting personnel, all at the University of Iowa, Krimigis at APL/JHU, and Sagalyn and Smiddy at AFCRL]

(c) Explorers 33 and 35

Both of these spacecraft continue to yield excellent data, Explorer 33 being over 39 months old in earth orbit and Explorer 35 being over 26 months old in lunar orbit. The combination of the particle and x-ray data from the two spacecraft at varying relative locations, both in the general vicinity of the earth, provides a valuable new dimension to the study of solar particles, shock waves, magnetospheric perturbations, electric fields in the magnetotail, etc. The long term, nearly continuous record of the soft x-ray emissions of the sun for 39 months (and continuing) is a unique body of data. A catalog of principal x-ray flares is published in the monthly "Solar-Geophysical Data" of the Environmental Science Services Administration. We have recently completed a major catalog of solar x-ray absolute intensities, nearly continuous with a time resolution of 82 (or 164) seconds, for the period 2 July 1966 to 18 September 1968. A complete set of computer listings and microfilm plots was transmitted to the National Space Science Data Center on 1 July 1969 and made available through that agency to qualified investigators.

in solar and ionospheric physics. The catalog is being continued and updated.

Particle shadowing by the moon has proven to be a valuable field of investigation on solar and magnetospheric electrons. The first determination of a significant upper limit on the alpha particle emissivity of the moon has been made with Explorer 35.

A large number of solar and magnetospheric particle phenomena have been observed in a unique way.

A substantial body of plots and computer tape tabulations of reduced data from Explorers 33 and 35 will be transmitted to the National Space Science Data Center within the near future.

Explorer 35 data have acquired enhanced interest recently since the spacecraft serves as an on-the-spot radiation monitor around the moon during Apollo 11, 12, 13, etc. manned lunar operations. Its observations can also support and supplement those made with intended lunar surface science instruments.

Despite this, NASA now plans to terminate flight operations and data processing for Explorer 33 and Explorer 35 on 15 October 1969. An attempt is being made to have Explorer 35 operations continued. One active suggestion is to transfer the telemetry acquisition to the North Liberty Radio Observatory.

(Data analysis supported by ONR)

[Van Allen, Drake, Innanen, Catalano, Oliven, Yeh, Venkatarangan, Sarris]

(d) Explorer 34 (IMP-F)

This spacecraft, in eccentric earth orbit, has provided a massive, detailed survey of low energy (30 to 70,000 eV) proton and electron phenomena throughout the magnetosphere (especially in the magnetotail and magnetopause) and in the solar wind. A number of important new results have been published or are in preparation. The spacecraft (IMP-F) was launched on 24 May 1967 and re-entered the earth's atmosphere on 3 May 1969.

Data analysis is continuing.

(Supported by GSFC/NASA)

[Frank, Owens, and Schield]

(e) Explorer 41 (IMP-G)

A University of Iowa experiment similar to that on Explorer 34 was included in this GSFC/NASA spacecraft launched on 21 June 1969. As of 31 August the orbital elements were: period 80.4 hrs, inclination 87.1°, apogee 96,977 km, and perigee 79,459 km. One portion of the U. of I. experiment was disabled after about 1100 hrs of successful operation by the failure of another instrument. The remainder of the U. of I. experiment (low energy proton electron differential energy analyzer) continues to operate properly and to provide valuable data on particles in the outer magnetosphere.

(Hardware and data reduction by GSFC/NASA)

[Frank, Yeager, and English]

(f) IMP-I

Work is progressing well on preparing two separate experiments for IMP-I (~ 1971 launch).

(Support by GSFC/NASA)

[Gurnett, Pfeiffer, et al. on VLF radio experiment]

[Frank, Yeager, et al. on low energy particle experiment]

(g) IMP-H and J

Work is underway on the construction of low energy particle electrostatic analyzers for these two spacecraft (~ 1972, 1973 launches).

(Support by GSFC/NASA)

[Frank et al.]

(h) Small Scientific Satellite (S^3-A)

The VLF group is one of the participants in preparation of a radiation belt experiment on this spacecraft (launch ~ 1970).

(Support by GSFC/NASA)

[Gurnett, Shawhan, et al.]

(i) German-American Solar Probe (Helios)

A proposal for a VLF radio experiment on this international spacecraft has been approved. Work is now underway. The space-

craft will be sent into a heliocentric orbit with a perihelion of about 0.3 astronomical units (launch ~ 1973).

(Support by GSFC/NASA)

[Gurnett, Pfeiffer, et al.]

(j) Injun VI

A proposal has been submitted to NASA for a small earth satellite to make the first observational study of the polar magnetosphere at large radial distances in the vicinity of the hypothetical "neutral point" in the earth's magnetic field. A d.c. magnetometer, magnetic and electric antennas and receivers, and a low energy electron-proton electrostatic analyzer are proposed. Operational aspects would be similar to those of Injun V.

The proposal to build and instrument such a satellite at the University of Iowa has received Category I ratings by both the Particles and Fields Subcommittee and the Ionosphere Subcommittee of NASA. A considerable amount of preparatory design work has been done under ONR support. However, the latest information from NASA is that no significant financial support for this program will be available before Fiscal Year 1972 (and this is, of course, uncertain). Hence, this program is now being deferred indefinitely, to our very considerable disappointment.

(k) Pioneers F/G (Asteroid/Jupiter Missions)

Our energetic particles experiment for an exploratory survey of the radiation belts of Jupiter has been approved and a contract has been received.

The design work is well underway (starting on 28 June 1969).

(Launches, March 1972 and April 1973)

(Support by Ames Research Center/NASA)

[Van Allen, Enemark, and Randall]

(l) UK-4

This low-altitude polar orbiting satellite is a joint British-American one. A U. of I. experiment on low energy electrons and protons in the magnetosphere (and especially over the auroral zones) has been approved. The experiment is similar to that on Injun V.

(Launch ~ 1973)

(GSFC/NASA)

[Frank, Craven, et al.]

(m) Proposals for Other Flight Missions

Proposals for flight on the following missions are under consideration:

ATS-G
Mercury/Venus Mission
Apollo-Lunar Landed Science

(n) Theory

Theoretical studies are being made on the propagation of solar protons, alpha particles, and electrons in interplanetary space; on the emission of x rays and radio noise by the sun; on the generation and propagation of very low frequency radio waves in the magnetosphere and on the relationship of such waves to particle acceleration, diffusion, and precipitation; on planetary atmospheres; on waves in the interplanetary medium; and on the radiation belts of Jupiter.

(Support by ONR and NASA)

[Gurnett, Knorr, Shawhan, Drake, Gibson, Innanen, and Taylor]

(o) Solar Radio Noise

Beginning in July 1967 the sun's radio noise has been monitored during sunlit hours at 1.95 cm with a Collins Radio Company radiometer-polarimeter at the North Liberty Radio Observatory. Of special interest is the study of the relationship of 1.95 cm radio flares to the soft x-ray flares and particle flares that are observed by Explorer 33 and Explorer 35.

(Support by ONR)

[Shawhan and Sarris]

(p) Structure of the Solar Corona

Through the courtesy of T. Gold, F. Drake, and G. Pettengill of Cornell University, one of our NASA graduate trainees, J. Rankin,

has spent the period March-September 1969 at the Arecibo Radio Observatory, observing pulsar NP0532. Of special interest was the probing of the radial dependence of electron density in the solar corona as determined during the passage of the pulsar by the sun. The closest approach was 65' of arc from the surface of the sun on 15 June 1969. A large volume of observational data was obtained. It appears that significant relativistic effects near the sun will also be determined.

(Supported by NASA)

[Rankin]

(q) Photometry of Major Planets

A program of absolute spectro-photometry of the major planets (especially Jupiter and Saturn) has been underway during 1969 using the U. of Iowa 24" reflector. Significant results have been obtained. Further support for this work is being sought from NSF and/or NASA.

[Neff]

4. Senior Academic Staff in Space Physics
[September 1969]

Van Allen, James A., Professor of Physics and Head of Department of Physics and Astronomy

Frank, Louis A., Associate Professor of Physics

Gurnett, Donald A., Associate Professor of Physics

Shawhan, S. D., Assistant Professor of Physics

Enemark, Donald C., Instructor

Schield, Milo A., Instructor

Craven, John D., Research Associate

Fennell, Joseph F., Research Associate

Pizzella, Guido, Research Associate

Also in closely related work
(astronomy and plasma physics)

Knorr, Georg, Associate Professor of Physics

Montgomery, David C., Associate Professor of Physics
[On leave June 1969--September 1970]

Neff, John S., Associate Professor of Astronomy

Fix, John D., Assistant Professor of Astronomy

Joyce, Glenn R., Assistant Professor of Physics

Nuehrenberg, Juergen, Research Associate

5. Senior Engineering and Administrative Staff
[September 1969]

Enemark, Donald C., Senior Electronics Engineer

Brechwald, Robert L., Senior Computer Programmer and Systems Analyst

Cessna, James R., Electronics Engineer

Rogers, John E., Project Manager

Douglas, F. Ben, Jr., Contracts Administrator

Pfeiffer, G. William, Research Physicist

Randall, Roger, Electronics Engineer

Henry, Kaye, Drafting Shop Supervisor

Freund, Edmund A., Supervisor, Departmental Machine Shop

Robison, Evelyn D., Publications Supervisor

Sonksen, Paul L., Data Reduction Supervisor

Dunlavy, D. David, Station Manager, North Liberty Radio Observatory

6. Junior Academic Staff in Space Physics

All of those listed below are graduate students, engaged in research in space physics.

	Appointment	Principal Research Project
Ackerson, Kent L.	Research Physicist [ONR-NASA]	Magnetospheric Particles (Injun IV)
Åkersten, S. Ingvar	Research Assistant [NASA]	Ionospheric Electron Density (Injun V)
Anderson, Roger R.	Research Physicist [NASA]	VLF Radio (Injun V)
Burns, A. Lee	NASA Trainee	Magnetospheric Protons (Injun IV)
Burns, Thomas B.	NASA Trainee	Plasma Theory
Catalano, Charles P.	Graduate Assistant	Solar X-Rays (Mariner V, Explorers 33 and 35)
Cauffman, David P.	Research Assistant [NASA]	VLF Radio (Injun V and Rockets)
DaCosta, Jose M.	International NASA Fellow	Pioneer F/G
Drake, Jerry F.	U. S. Steel Fellow	Solar X Rays (Explorers 33 and 35)
Flindt, Herbert R.	NDEA Fellow	Magnetospheric Theory
Innanen, William G.	Research Assistant [NASA]	Solar Protons (Explorers 33 and 35)
Ketterer, Harold E.	Research Assistant [NASA]	Low Energy Magnetospheric Particles (IMP's-H, I, and J)
Mosier, Stephen R.	Research Physicist [NASA]	VLF Radio (Injun V)

	Appointment	Principal Research Project
Oliven, Melvin N.	Research Assistant [ONR]	Magnetospheric Electrons (Explorers 33 and 35)
Randall, Bruce A.	NDEA Fellow	Magnetospheric Electrons (Injun V)
Rankin, John M.	Research Assistant [ONR]	Pulsars and Solar Corona (Arecibo)
Rodriguez, Paul	Research Assistant [NASA]	VLF Radio (Injun V)
Saflekos, Nicolaos	Graduate Student	---
Sarris, Emanuel	Research Assistant [ONR]	Solar X Rays and Radio Bursts
Shaw, Robert R.	Research Assistant [NASA]	Laboratory Plasma
Taylor, William W. L.	Research Assistant [NASA]	Plasma Theory
Tsai, Chin-Ming	Research Assistant [NASA]	Plasma Theory
Vahala, George M.	Research Assistant [NASA]	Plasma Waves
Venkatarangan, Penugonde	Research Assistant [ONR]	Solar Cosmic Rays (Explorers 33 and 35)
Wing, William R.	Teaching-Research Fellow	Laboratory Plasma
Yeager, David M.	Research Physicist [ONR-NASA]	Magnetospheric Physics (Injun V and Explorer 41)
Yeh, Richard	Research Assistant [ONR]	Lunar Alpha Particles (Explorer 35)

7. Advanced Degrees Awarded in Space Physics at U. of Iowa 1 January 1969--30 September 1969

M.S. Degree

Åkersten, Sixten Ingvar (Aug. 1969), "Occultation of Solar X Rays by Model Planetary Atmospheres"

Anderson, Roger R. (June 1969), "Observations of Lower Hybrid Resonance Phenomena with the Injun 5 Satellite"

Bisht, Tribhuwan K. (June 1969), "Particle Acceleration in Plasmas"

Cauffman, Mavis (June 1969), "Electric Fields in the Magnetosphere"

Kanbach, Gottfried (Aug.,1969), "Measurements of Low Energy Protons in the Earth's Magnetic Tail"

Loftus, Thomas A. (Aug. 1969), "Disturbance of the Inner Van Allen Belt as Observed by Explorer I"

Randall, Bruce A. (June 1969), "Solid State Detectors on Injun V"

Rodriguez, Paul (June 1969), "Experimental Observations of Mode Coupling from Injun 3 VLF Data"

Vahala, George M. (June 1969), "Quasi-Linear Theory of the Ion-Wave Instability"

Yeager, David M. (February 1969), "Sudden Depletions of Electrons in the Middle of the Outer Radiation Zone"

Ph.D. Degree

Craven, John D. (Aug. 1969), "On the Deposition of Magnetospheric Electrons into the Earth's Upper Atmosphere"

Gibson, Sister M. Jean, O.S.B. (June 1969), "The Correlation of X-Ray Radiation (2-12 A°) with Microwave Radiation (10.7 cm) from the Non-Flaring Sun"

8. Research Reports and Publications
1 January 1969--30 September 1969

J. A. VAN ALLEN and N. F. NESS
Particle Shadowing by the Moon
J. Geophys. Res., 74, 71-93, 1969

C. S. R. RAO
Some Observations of Energetic Electrons in the Outer Radiation Zone During Magnetic Bays
J. Geophys. Res., 74, 794-801, 1969

DAVID P. CAUFFMAN and DONALD A. GURNETT
VLF Emissions During Magnetic Storms and Their Association with 40 keV Electrons
J. Geophys. Res., 74, 1144-1157, 1969

M. A. SCHIELD
Pressure Balance Between Solar Wind and Magnetosphere
J. Geophys. Res., 74, 1275-1286, 1969

DAVID MONTGOMERY and GLENN JOYCE
Shock-Like Solutions of the Electrostatic Vlasov Equation
J. Plasma Phys., 3, 1-11, 1969

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [January 1969], IER-FB-293, 129, ESSA Environmental Data Service, U. S. Department of Commerce

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [February 1969], IER-FB-294, 129, ESSA Environmental Data Service, U. S. Department of Commerce

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [February 1969], IER-FB-294 (Supplement), 62-63, ESSA Environmental Data Service, U. S. Department of Commerce

J. A. VAN ALLEN
Solar X-Ray Flares on May 23, 1967
World Data Center A, Upper Atmosphere Geophysics Report UAG-5, February 1969, pp. 46-47
[See also Astrophys. J., 152, L85-L86, 1968]

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [March 1969], IER-FB-295, 138-139
ESSA Environmental Data Service, U. S. Department of Commerce

G. P. HASKELL
Anisotropic Fluxes of Energetic Particles in the Outer Magnetosphere
J. Geophys. Res., 74, 1740-1748, 1969

S. D. SHAWHAN
Whistlers--Use for Determination of Composition and Temperature
ESRIN-ESLAB Symposium on Low Frequency Waves and Irregularities in the Ionosphere, Frascati, Italy, 23-27 Sept. 1968, Proceedings, Reidel Publishing Company, 1969

L. A. FRANK
Low Energy Charged Particles in the Earth's Magnetosphere
Advanced Space Experiments, 25, 475-478, Advances in the Astronautical Sciences, 1969

JAMES A. VAN ALLEN
Charged Particles in the Magnetosphere
Reviews of Geophysics, 7, 233-255, February-May 1969
[Magnetospheric Physics, Proc. International Symposium on the Physics of the Magnetosphere, Washington, D. C., September 3-13, 1968, ed. by Donald J. Williams and Gilbert D. Mead]

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [April 1969], IER-FB-296, 163-164
ESSA Environmental Data Service, U. S. Department of Commerce

A. HIROSE, I. ALEXEFF, W. D. JONES, N. A. KRALL, and D. MONTGOMERY
Landau Damping of Electrostatic Ion Waves in a Uniform Magnetic Field
Phys. Letters, 29A, 31-32, 1969

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [May 1969], IER-FB-297, 144
ESSA Environmental Data Service, U. S. Department of Commerce

J. A. VAN ALLEN and C. D. WENDE
The Solar Flare of July 8, 1968
J. Geophys. Res., 74, 3046-3048, 1969

J. A. VAN ALLEN, C. D. WENDE, and S. R. MOSIER
The North Liberty Radio Observatory of the University of Iowa
Solar Physics, 7, 159-163, 1969

DAVID MONTGOMERY
Fluctuations in Monatomic Gases
Phys. Fluids, 12, 804-809, 1969

P. R. SENGUPTA
Effect of $\lambda < 10$ A° Solar X-Rays on the Ionosphere between 60 and 100 km
Journal of the Institution of Telecommunication Engineers, India, Vol. 15, No. 5, pp. 315-328, 1969

L. A. FRANK, N. K. HENDERSON, and R. L. SWISHER
Degradation of Continuous-Channel Electron Multipliers in a Laboratory Operating Environment
Rev. Sci. Instr., 40, 685-689, 1969

DONALD A. GURNETT and STEPHEN R. MOSIER
VLF Electric and Magnetic Fields Observed in the Auroral Zone with the Javelin 8.46 Sounding Rocket
J. Geophys. Res., 74, 3979-3991, 1969

S. M. KRIMIGIS and D. VENKATESAN
The Radial Gradient of Interplanetary Radiation Measured by Mariners 4 and 5
J. Geophys. Res., 74, 4129-4145, 1969

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [July 1969], IER-FB-299,
Part II, 57, ESSA Environmental Data Service,
U. S. Department of Commerce

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Catalog of Solar X-Rays
Solar Geophysical Data [July 1969], IER-FB-299,
Part II, 84, ESSA Environmental Data Service,
U. S. Department of Commerce

PETER D. NOERDLINGER
Quasi-Stellar Objects and the Density of Intergalactic Hydrogen
Astrophys. J., 156, 841-846, 1969

J. A. VAN ALLEN
Catalog of Solar X-Rays
Solar-Geophysical Data [August 1969], SGD 300,
Part II, 58-59, ESSA Environmental Data Service
U. S. Department of Commerce

DONALD A. GURNETT, G. WILLIAM PFEIFFER, ROGER R. ANDERSON, STEPHEN R. MOSIER, and DAVID P. CAUFFMAN
Initial Observations of VLF Electric and Magnetic Fields with the Injun 5 Satellite
J. Geophys. Res., 74, 4631-4648, 1969

DAVID MONTGOMERY
Nonlinear Vlasov Plasmas: Initial Value Problem and Response to an External Field
Statistical Physics of Charged Particle Systems, R. Kubo and T. Kihara, Editors, Syokabo-Benjamin (New York and Tokyo), 1969, pp. 156-177

CHARLES D. WENDE
Correlation of Solar Microwave and Soft X-Ray Radiation
1. The Solar Cycle and Slowly Varying Components
J. Geophys. Res., 74, 4649-4660, 1969

PETER D. NOERDLINGER
Universal Cosmic Rays and Harrison's Inhomogeneity Postulate
Phys. Rev., 181, 2143, 1969

STEPHEN R. MOSIER and DONALD A. GURNETT
Ionospheric Observation of VLF Electrostatic Noise Related to Harmonics of the Proton Gyrofrequency
Nature, 223, 605-606, 1969

J. A. VAN ALLEN
Preliminary Notes on the Magnetic Alignment of Injun V
U. of Iowa Research Report 69-1

P. R. SENGUPTA
Solar X-Ray Control of the E Layer of the Ionosphere
U. of Iowa Research Report 69-3

C. S. R. RAO
Local Time Asymmetries in the Increase of Electron Fluxes in the Outer Van Allen Zone during Substorm
U. of Iowa Research Report 69-8
Submitted to J. Geophys. Res. (in press)

J. D. CRAVEN and K. L. ACKERSON
The Explorer 25 (Injun 4) Satellite: Subsystems and Data Reduction
U. of Iowa Research Report 69-9

THOMAS P. ARMSTRONG and DAVID MONTGOMERY
Numerical Study of Weakly Unstable Electron Plasma Oscillations
U. of Iowa Research Report 69-10
Phys. Fluids [October 1969]

D. M. YEAGER and L. A. FRANK
Large Temporal Variations of Energetic Electron Intensities at Mid-Latitudes in the Outer Radiation Zone
U. of Iowa Research Report 69-13
J. Geophys. Res. [1 November 1969]

W. G. INNANEN
On the Determination of Particle Spectra with Solid State Detectors Having Two or Three Nested Energy Channels
U. of Iowa Research Report 69-16

CHARLES D. WENDE
The Correlation of Solar Microwave and Soft X-Ray Radiation. 2. The Burst Component
U. of Iowa Research Report 69-18
Submitted to J. Geophys. Res. (in press)

BRUCE A. RANDALL [M.S. Thesis]
Solid State Detectors on Injun V
U. of Iowa Research Report 69-22

L. A. FRANK
On the Presence of Low Energy Protons ($5 \leqslant E \leqslant 50$ keV) in the Interplanetary Medium
U. of Iowa Research Report 69-24
J. Geophys. Res. [1969]

STEPHEN R. MOSIER and DONALD A. GURNETT
VLF Measurements of the Poynting Flux Along the Geomagnetic Field with the Injun 5 Satellite
U. of Iowa Research Report 69-27
J. Geophys. Res. [1 November 1969]

J. A. VAN ALLEN
On the Electric Field in the Earth's Distant Magnetotail
U. of Iowa Research Report 69-29
J. Geophys. Res. (in press)

J. A. VAN ALLEN
Further on Electron Shadowing by the Moon
U. of Iowa Research Report 69-30

L. A. FRANK and H. D. OWENS
Low-Energy Proton ($0.5 \leq E \leq 50$ keV) Omnidirectional Intensity Contours in the Earth's Outer Radiation Zone at the Magnetic Equator
U. of Iowa Research Report 69-32
Submitted to J. Geophys. Res. (in press)

JERRY F. DRAKE, SR. JEAN GIBSON, O.S.B., and JAMES A. VAN ALLEN
Iowa Catalog of Solar X-Ray Flux (2-12 A°)
U. of Iowa Research Report 69-36
Solar Physics (in press)

RICHARD S. YEH and JAMES A. VAN ALLEN
Alpha Particle Emissivity of the Moon--An Observed Upper Limit
U. of Iowa Research Report 69-38
Science (in press)

L. A. FRANK
Direct Detection of the Asymmetric Injection of Extra-terrestrial 'Ring Current' Protons into the Outer Radiation Zone
U. of Iowa Research Report 69-39

J. D. CRAVEN
A Survey of Low-Energy ($E \geq 5$ keV) Electon Energy Fluxes over the Northern Auroral Regions with Satellite Injun 4
U. of Iowa Research Report 69-40
Submitted to J. Geophys. Res.

JERRY F. DRAKE
Characteristics of 2-12 A° Solar X-Ray Flares
U. of Iowa Research Report 69-41

L. A. FRANK
Further Comments Concerning Low-Energy Charged Particle Distributions within the Earth's Magnetosphere and Its Environs
U. of Iowa Research Report 69-42

DONALD A. GURNETT and DAVID P. CAUFFMAN
Double Probe Measurements of DC Electric Fields with the Injun 5 Satellite
U. of Iowa Research Report 69-45

M. A. SCHIELD and L. A. FRANK
Electron Observations Between the Inner Edge of the Plasma Sheet and the Plasmasphere
U. of Iowa Research Report 69-46
Submitted to J. Geophys. Res. (in press)

P. VENKATARANGAN, D. VENKATESAN, and J. A. VAN ALLEN
Solar Flare Increases in Cosmic Ray Intensity on November 18, 1968; February 25, 1969; and March 30, 1969
U. of Iowa Research Report 69-47
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JAMES A. VAN ALLEN
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